

## PATENT ABSTRACTS OF JAPAN

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(72)Inventor : FUKUYOSHI KENZO  
KIMURA YUKIHIRO

### (54) ELECTRODE PLATE FOR DISPLAY DEVICE

#### (57)Abstract:

**PURPOSE:** To provide an electrode plate for a display device having transparent electrodes which are thin films adequately utilized for display of a broad screen with high quality and have a high electrical conductivity.

**CONSTITUTION:** The main part of this electrode plate for the display device is composed of a glass substrate 11 and the transparent electrodes 12 consisting of three-layered films laminated with thin films 12a and 12c of a high carrier concn. which consists essentially of indium oxide and is formed by adding 10wt.% tin oxide as a dopant into this indium oxide and a thin film 12b of high carrier mobility which consists essentially of indium oxide and is formed by adding 0.3wt.% tin oxide as a dopant into the indium oxide adjacently to each other. The three-layered films act on each other in the transparent electrodes 12 and, therefore, the specific resistance and area resistance are decreased as a whole. Consequently, the high electrical conductivity is obtd. regardless of the thin films.



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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the electrode plate for displays used for a liquid crystal display, an input/output device, etc., and relates to improvement of the electrode plate for displays provided with the transparent electrode which moreover has high conductivity with a thin film especially.

[0002]

[Description of the Prior Art]The electrode plate with which the transparent electrode which penetrates visible light was provided on substrates, such as glass and a plastic film, is widely used for the input/output device which carries out a direct entry from the display screen of the electrode for a display of various displays, such as a liquid crystal display, or this display.

[0003]For example, the transparent electrode plate of the display device with which the liquid crystal was used, Color filter layer b which is provided in the pixel part on glass substrate a and this glass substrate a, and colors that transmitted light red, green, and blue for every pixel, respectively as shown in drawing 4, The light-shielding film c which is provided in the part (part between pixels) between the pixels on the above-mentioned glass substrate a, and prevents the light transmission from this part. That principal part comprises the orienting film f formed on the transparent electrode e formed on the protective layer d provided all over the above-mentioned color filter layer b, and this protective layer d, and this transparent electrode e. And the above-mentioned transparent electrode e is constituted by the transparent conducting film which was patterned after the predetermined pattern and formed.

[0004]As this transparent conducting film, the ITO thin film which added tin oxide as a dopant in indium oxide is widely used paying attention to that high conductivity, How (the substrate-heating forming-membranes method) to carry out vacuum film formation by sputtering process, and form at the formation method on glass substrate a heated by not less than 200 \*\* high

temperature, The method (annealing method after low-temperature membrane formation) of carrying out afterbaking annealing and forming which carried out vacuum film formation by sputtering process on glass substrate a held at low temperature 150 ° or less is known.

[0005]In order to improve the etching fitness of this ITO thin film, what formed the ITO thin film and the indium oxide thin film using the above-mentioned substrate-heating forming-membranes method, and was used as the transparent conducting film of multilayer structure (JP,4-58225,A) is known.

[0006]In addition, although the tin oxide thin film, the thin film (Nesa membrane) constituted by this tin oxide by adding antimony oxide, the thin film constituted by the zinc oxide by adding an aluminum oxide, etc. are known, The conductivity is inferior to the above-mentioned ITO thin film or the above-mentioned transparent conducting film of multilayer structure in each of these, and since chemical resistance or a water resisting property to acid, alkali, etc., etc. is insufficient, generally they has not spread.

[0007]

[Problem(s) to be Solved by the Invention]By the way, in the above-mentioned display device or a display input device, In recent years, it is required that increasing picture element density and displaying a precise screen should be called for, and eburnation of the above-mentioned transparent electrode pattern should be demanded in connection with this, for example, the terminal area of the above-mentioned transparent electrode should be constituted from a pitch which is about 100 micrometers. In the method (COG) with which direct continuation of the IC for a liquid crystal drive is carried out to a substrate in an LCD device, there is a portion from which leading about of wiring serves as a small-gage wire of 20-50 micrometers in width, and the advanced etching processing fitness which is not in the former is demanded.

[0008]In order to also call for enlargement of the display screen on the other hand, to form the transparent electrode of a precise pattern which was mentioned above about such a big screen and to be able to impress sufficient driver voltage for a liquid crystal moreover, the transparent conducting film provided with conductivity high as the above-mentioned transparent electrode needed to be applied.

[0009]Generally the conductivity of this transparent conducting film is expressed with sheet resistivity ( $\Omega/\square$ ) (sheet resistivity is a reciprocal of area conductivity), for example, low sheet resistivity called 5ohms /  $\square$  grade is demanded as that value. This sheet resistivity is expressed with the value which broke above-mentioned specific resistance by thickness of the transparent conducting film.

[0010]And by the product of conductivity (conductivity is expressed with the reciprocal of the above-mentioned specific resistance), and thickness, the area conductivity of the above-mentioned transparent conducting film is expressed, and this conductivity  $\sigma$  ( $\Omega^{-1}$  and  $\text{cm}^{-1}$ ). It is expressed by the product of the mobility  $\mu$  ( $\text{cm}^2/\text{V}\cdot\text{sec}$ ) of the electric charge  $e$

(coulomb) which the career (an electron or an electron hole) contained in a film has, and this career, and the concentration  $n$  of a career ( $\text{cm}^{-3}$ ).

[0011]

$$\sigma(\omega^{-1} \text{ and } \text{cm}^{-1}) = e \cdot \mu \cdot n \quad (1)$$

Therefore, what is necessary is just to increase either or the both sides of the mobility  $\mu$  ( $\text{cm}^2/\text{V}\cdot\text{sec}$ ) or the concentration  $n$  of a career ( $\text{cm}^{-3}$ ), in order to raise the conductivity of the above-mentioned transparent conducting film and to reduce that specific resistance and sheet resistivity from this (1) type.

[0012] And in the ITO thin film currently used widely as the above-mentioned transparent conducting film, From participating in generation of the electron whose tin oxide is a dopant of indium oxide and in which this dopant is a career as mentioned above. It is expected that the concentration  $n$  of a career ( $\text{cm}^{-3}$ ) will increase if the quantity of the above-mentioned tin oxide is made to increase, conductivity and area conductivity increase in connection with this, and sheet resistivity decreases.

[0013] About the ITO thin film of 280 nm of thickness formed using the annealing method after low-temperature membrane formation, make the addition of the above-mentioned tin oxide change it, and However, the specific resistance ( $\text{ohm}\cdot\text{cm}$ ), Carrier mobility  $\mu$  ( $\text{cm}^2/\text{V}\cdot\text{sec}$ ), carrier concentration  $n$  ( $\text{cm}^{-3}$ ), And when sheet resistivity ( $\text{ohm}/\square$ ) was measured, as shown in the following table 1, when the addition of tin oxide exceeded 5 % of the weight, the specific resistance of the ITO thin film became an approximately regulated value (about  $2.4 \times 10^{-4} \text{ ohm}\cdot\text{cm}$ ), and even if it made the addition of tin oxide increase by more than this, the fall of specific resistance was not seen. Although this reason is unknown, The ion radius of Sn (tin) is about 0.74 Å to the ion radius of In (indium) being about 0.92 Å, Since distortion of an indium oxide crystal becomes large with the increase in the tin oxide added from the difference of both ion radius being large, that to which a crystal defect increases, it originates in this, and the above-mentioned mobility  $\mu$  ( $\text{cm}^2/\text{V}\cdot\text{sec}$ ) is falling is conjectured.

[0014]

[Table 1]

酸化錫添加量 (重量%)	キャリア濃度 ( $\text{cm}^{-3}$ )	キャリア移動度 ( $\text{cm}^2/\text{V} \cdot \text{sec}$ )	比抵抗 ( $\Omega \cdot \text{cm}$ )	面積抵抗 ( $\Omega/\square$ )
0	$2.38 \times 10^{20}$	96.1	$2.73 \times 10^{-4}$	9.75
0.3	$3.20 \times 10^{20}$	85.5	$2.28 \times 10^{-4}$	8.14
5.0	$7.49 \times 10^{20}$	34.2	$2.44 \times 10^{-4}$	8.71
7.5	$9.49 \times 10^{20}$	29.1	$2.26 \times 10^{-4}$	8.07
10.0	$9.51 \times 10^{20}$	27.1	$2.43 \times 10^{-4}$	8.68

[0015] And since the specific resistance of an ITO thin film does not fall from  $2.4 \times 10^{-4}$   $\Omega \cdot \text{cm}$  about from the result mentioned above even if it changes the concentration of tin oxide, in order to obtain the ITO thin film which has the sheet resistivity about 50  $\Omega/\square$ , it is necessary to set the thickness as not less than 300 nm.

[0016] However, in the LCD device which uses a STN (supertwisted nematic) liquid crystal, As shown in [drawing 4](#), it is necessary to form the orienting film f for carrying out orientation of the liquid crystal on the transparent electrode e. When the thickness of the above-mentioned ITO thin film is set as about 300 nm, this ITO thin film is patterned and the transparent electrode e is formed. Since the level difference of about 300 nm will be produced by the part where this ITO thin film exists, and the part not existing and unevenness of about 300 nm will be formed in the orienting film f surface in connection with this, there was a problem the orientation defect called a domain becomes easy to produce.

[0017] The transparent conducting film of the multilayer structure indicated to above-mentioned JP,4-58225,A is formed using the substrate-heating forming-membranes method, and This sake, As shown in Table 2, the carrier mobility of an indium oxide thin film is small, and only the thin film of the large specific resistance which is a  $15 - 20 \times 10^{-4}$   $\Omega \cdot \text{cm}$  grade is obtained.

[0018]

[Table 2]

基板温度 (°C)	アニーリング温度 (°C)	キャリア濃度 ( $\text{cm}^{-3}$ )	キャリア移動度 ( $\text{cm}^2/\text{V} \cdot \text{sec}$ )	比抵抗 ( $\Omega \cdot \text{cm}$ )
室温	220	$2.38 \times 10^{20}$	96.1	$2.73 \times 10^{-4}$
200	アニーリングなし	$1.13 \times 10^{20}$	27.3	$20.3 \times 10^{-4}$
220	アニーリングなし	$1.02 \times 10^{20}$	39.2	$15.6 \times 10^{-4}$

[0019] This invention was made paying attention to such a problem, and there is a place made into the technical problem in providing the electrode plate for displays provided with the transparent electrode which moreover has high conductivity with a thin film.

[0020]

[Means for Solving the Problem] Then, in order to attain such a purpose, when this invention person etc. repeated research wholeheartedly, it came to make the following technical discovery. Namely, laminate two transparent conducting films in which carrier concentration  $n$  ( $\text{cm}^{-3}$ ) differs both from carrier mobility  $\mu$  ( $\text{cm}^2/\text{V} \cdot \text{sec}$ ) so that it may adjoin mutually, and a two-layer transparent electrode is formed, A place which changed material and was respectively measured about conductivity of this two-layer transparent electrode, Carrier mobility  $\mu_m$  ( $\text{cm}^2/\text{V} \cdot \text{sec}$ ) of transparent conducting film (M) of one of these is large enough compared with carrier mobility  $\mu_c$  of a transparent conducting film (C) of another side, Carrier concentration  $n_c$  ( $\text{cm}^{-3}$ ) of a transparent conducting film (C) of another side compared with carrier concentration  $n_m$  of above-mentioned one transparent conducting film (M) And when large enough, Conductivity  $\sigma'$  ( $\Omega^{-1}$  and  $\text{cm}^{-1}$ ) of the whole transparent electrode Conductivity  $\sigma_m = e \cdot \mu_m$  and  $n_m$  of each transparent conducting film simple substance, And also when it became large and a multilayer more than two-layer moreover constituted the above-mentioned transparent electrode from any of  $\sigma_c = e \cdot \mu_c$  and  $n_c$ , it was able to discover becoming large similarly.

[0021] This invention is made based on such technical discovery.

[0022] Namely, an invention concerning claim 1 is premised on an electrode plate for displays provided with a transparent electrode constituted with a transparent conducting film on a substrate, The above-mentioned transparent conducting film is constituted by a bilayer film or a multilayer film of a high career high mobility thin film of carrier mobility, and a career high concentration thin film with high carrier concentration which adjoined mutually and was laminated.

[0023]And according to the electrode plate for displays concerning this claim 1, it comprises a bilayer film or a multilayer film of a high career high mobility thin film of carrier mobility, and a career high concentration thin film with high carrier concentration which that transparent electrode adjoined mutually and was laminated, In order that each thin film of the above-mentioned bilayer film or a multilayer film may act each other mutually, it becomes possible to decrease the specific resistance and sheet resistivity as a whole.

[0024]Next, in order to make it correspond to densification of the latest display and to form a transparent electrode of a precise pattern. It is desirable for the above-mentioned career high mobility thin film to have the carrier mobility more than  $60\text{-cm}^2/\text{V}\cdot\text{sec}$ , and for the above-mentioned career high concentration thin film to have the carrier concentration more than  $9 \times 10^{20}\text{cm}^{-3}$ .

[0025]An invention concerning claim 2 is made from such a reason for technical.

[0026]Namely, an invention concerning claim 2 is premised on an electrode plate for displays concerning the invention according to claim 1, Carrier mobility of the above-mentioned career high mobility thin film is more than  $60\text{-cm}^2/\text{V}\cdot\text{sec}$ , and it is characterized by carrier concentration of the above-mentioned career high concentration thin film being more than  $9 \times 10^{20}\text{cm}^{-3}$ .

[0027]Here, metallic compounds in which a dopant is not added as a career high mobility thin film in an invention concerning claim 1 or 2, or a little dopants were added can constitute this. As for this career high mobility thin film, it is preferred to form membranes with the above-mentioned annealing method after low-temperature membrane formation. That is, it is because it becomes difficult to increase carrier mobility when membranes are formed using the substrate-heating forming-membranes method.

[0028>About the above-mentioned career high concentration thin film, this can be constituted with metallic compounds in which comparatively a lot of dopants were added.

[0029]And as metallic compounds which constitute the principal part of the above-mentioned career high mobility thin film or a carrier high concentration thin film, metallic compounds, such as indium oxide, titanium nitride, zirconium nitride, a zinc oxide, tin oxide, and rhenium oxide, can be applied, and it is indium oxide preferably.

[0030]As a dopant, a compound of metal in which a metal atom in the above-mentioned metallic compounds differs from a valence is applicable. For example, when the above-mentioned metallic compounds are indium oxide. Tin, a zirconium, titanium, germanium with which this indium atom differs from a valence, A compound of metal, such as lead, antimony, hafnium, magnesium, a scandium, yttrium, a lanthanum, cerium, praseodymium, neodymium, samarium, thallium, bismuth, vanadium, niobium, and tantalum, can be illustrated. And as an example of a compound of this metal, Tin oxide, zirconium oxide, titanium oxide, a germanium

dioxide, lead oxide, Antimony oxide, oxidation hafnium, magnesium oxide scandium oxide, Metallic oxides, such as yttrium oxide, a lanthanum trioxide, cerium oxide, praseodymium oxide, neodymium oxide, samarium oxide, thallium oxide, bismuth oxide, vanadium oxide, niobium oxide, and tantalum oxide, are mentioned. When the above-mentioned metallic compounds are indium oxide, it adds to this indium oxide in large quantities and carrier concentration is made to increase to it, tin oxide can be illustrated as a dopant with comparatively few falls of carrier mobility. As a dopant which is hard to produce a fall of carrier concentration by adding in very small quantities to the above-mentioned indium oxide on the other hand, Zirconium oxide, titanium oxide, a germanium dioxide, lead oxide, antimony oxide, oxidation hafnium, magnesium oxide, etc. besides the above-mentioned tin oxide can be illustrated, and tin oxide, zirconium oxide, oxidation hafnium, and titanium oxide can apply preferably especially. It is also possible to constitute the above-mentioned career high mobility thin film with metallic compounds which do not add such a dopant.

[0031]And when metallic compounds are made into indium oxide, in order to obtain carrier concentration more than  $9 \times 10^{20} \text{ cm}^{-3}$ , it is necessary to add a dopant 4% of the weight or more. On the other hand, in order to obtain carrier mobility more than  $60\text{-cm}^2/\text{V}\cdot\text{sec}$ , even if it is a case where did not add a dopant or it adds, it is desirable to hold down to 3 or less % of the weight of a minute amount.

[0032]An invention concerning claims 3-8 is made based on such a reason for technical.

[0033]Namely, an invention concerning claim 3 is premised on an electrode plate for displays concerning the invention according to claim 1 or 2, An invention where the above-mentioned transparent conducting film is characterized by being constituted with an indium oxide thin film which added a dopant and which requires it for claim 4 is characterized by the above-mentioned dopant being tin oxide a premise [ an electrode plate for displays concerning the invention according to claim 3 ].

[0034]On the other hand, an invention concerning claim 5 is premised on an electrode plate for displays concerning the invention according to claim 3, An invention which is characterized by the above-mentioned dopant being zirconium oxide, and relates to claim 6, An invention which is characterized by the above-mentioned dopant being oxidation hafnium a premise [ an electrode plate for displays concerning the invention according to claim 3 ], and relates to claim 7, It is characterized by the above-mentioned dopant being titanium oxide a premise [ an electrode plate for displays concerning the invention according to claim 3 ].

[0035]An invention concerning claim 8 is premised on an electrode plate for displays concerning the invention according to claim 1 to 7, The above-mentioned career high mobility thin film is constituted by indium oxide thin film which added a dopant zero to 3% of the weight, and a career high concentration thin film is constituted by indium oxide thin film which added a dopant 4% of the weight or more.



[0036]Although the transparent conducting film concerning this invention can constitute this from a bilayer film which comprises a career high mobility thin film and a career high concentration thin film of a monolayer respectively, The above-mentioned career high mobility thin film and a career high concentration thin film may be laminated by turns, a multilayer film of three or more layers may be constituted, and the above-mentioned transparent conducting film may consist of this multilayer film. When productivity is taken into consideration, about 2-6 layers are advantageous. The above-mentioned career high mobility thin film and a career high concentration thin film are used as a thin film (tens of Å - hundreds of Å), It is also possible to laminate this thin film by turns, to constitute a multilayer film of six or more layers, to set thickness of a career high mobility thin film below to the length of a mean free path of a career, and to raise the characteristic of a transparent electrode. Even if it is arbitrary about a crystal grain diameter of career high mobility thin films, such as this, and a career high concentration thin film and is 100 Å or less in fine particle diameter, it is possible to secure high carrier mobility and carrier concentration, but. It is desirable for an orientation direction [generally (222), it is easy to carry out orientation to a field or (400) a field] and a grating constant of a crystal which constitute the above-mentioned career high mobility thin film and a career high concentration thin film to have gathered mutually. As for sum total thickness of these thin films, in order to secure etching fitness in the case of patternizing, it is desirable that it is 300 nm or less.

[0037]Next, in an invention concerning claims 1-8, as a substrate used as a base material of a transparent electrode, glass, ceramics, a plastic film, a plastic board, etc. can be applied, and it may be colored black, white, or other colors. In order to improve heat dissipation nature and rigidity, it is also possible to use a substrate backed with a metal plate etc. A color filter layer which colors the transmitted light may be provided on a board which constitutes these substrates, or it may have composition which provided inorganic matter of this color filter layer, or an organic protective layer with this color filter layer. As such a color filter layer, A color filter layer of a pigment dispersion method formed in a photolitho process using coloring photoresist distributed in a photopolymer by using an organic color as a color material, A color filter layer etc. which were formed with printing methods, such as offset printing, intaglio offset printing, screen-stencil, and flexographic printing, can be illustrated.

[0038]

[Function]According to the invention concerning claims 1-8, it is constituted by the bilayer film or multilayer film of the high career high mobility thin film of carrier mobility, and a career high concentration thin film with high carrier concentration which the transparent electrode adjoined mutually and was laminated, In order that each thin film of the above-mentioned bilayer film or a multilayer film may act each other mutually, it becomes possible to decrease the specific resistance and sheet resistivity as a whole.

[0039]

[Example] With reference to drawings, the example of this invention is described in detail below.

[Example 1] As the electrode plate for displays concerning this example is shown in drawing 1, that principal part comprises the 0.7-mm-thick glass substrate (float blue plate provided with the undercoat layer of  $\text{SiO}_2$ ) 11, and the transparent electrode 12 provided on this glass substrate 11.

[0040] The carrier high concentration thin film 12a of 90 nm of thickness laminated one by one on the glass substrate 11 so that the above-mentioned transparent electrode 12 might adjoin mutually. It is constituted by three layer membranes of 280 nm of sum total thickness which comprises the carrier high mobility thin film 12b of 100 nm of thickness, and the carrier high concentration thin film 12c of 90 nm of thickness.

[0041] The above-mentioned carrier high concentration thin film 12a and the carrier high concentration thin film 12c are constituted by the thin film which used indium oxide as the main ingredients and in which 10% of the weight of tin oxide was added as a dopant in this indium oxide.

On the other hand, the above-mentioned carrier high mobility thin film 12b is constituted by the thin film which used indium oxide as the main ingredients and in which 0.3% of the weight of tin oxide was added as a dopant in this indium oxide.

And these thin films 12a, 12b, and 12c, After membranes are formed without all heating the glass substrate 11 by the magnetron sputtering method which uses an ITO target using the annealing method after low-temperature membrane formation, on the conditions of 200 °C to 1 hour, heating annealing processing is performed and it is formed.

[0042] And the carrier mobility, carrier concentration, specific resistance, and sheet resistivity were measured about the transparent electrode 12 which comprised these thin films 12a, 12b, and 12c.

[0043] As a result, as for  $48.6\text{-cm}^2/\text{V-sec}$  and carrier concentration,  $8.57 \times 10^{20}\text{-cm}^{-3}$  and specific resistance of carrier mobility were  $1.50 \times 10^{-4}\text{-ohm-cm}$ , and sheet resistivity was  $5.4\text{-ohm}/\square$ .

[0044] "Check" By comparing this result with said table 1, the fact of (1) - (3) was able to be checked below.

(1) The transparent electrode 12 concerning Example 1 which comprised the above-mentioned thin films 12a, 12b, and 12c, As compared with the thin film (refer to Table 1) in which tin oxide was added 0.3% of the weight, that carrier mobility has the high carrier concentration of a low thing, and, for this reason, that specific resistance and sheet resistivity are set up remarkably low as a whole.

(2) The transparent electrode 12 concerning Example 1 which comprised the above-mentioned thin films 12a, 12b, and 12c, As compared with the thin film (refer to Table 1) in which tin oxide was added 10% of the weight, that carrier concentration has the high carrier mobility of a low thing, and, for this reason, that specific resistance and sheet resistivity are set up remarkably low as a whole.

(3) Even if it compares the transparent electrode 2 concerning Example 1 which comprised the above-mentioned thin films 12a, 12b, and 12c with which thin film (refer to Table 1) obtained when changing the addition of tin oxide in 0 to 10% of the weight of the range, specific resistance and sheet resistivity are set up remarkably low.

[Example 2] As the electrode plate for displays concerning this example is shown in drawing 2, that principal part comprises the 1.1-mm-thick glass substrate 21 and the transparent electrode 22 provided on this glass substrate 21.

[0045]The above-mentioned transparent electrode 22 is constituted by the two-layer film of 270 nm of sum total thickness which comprises the career high concentration thin film 22a of 180 nm of thickness laminated one by one, and the career high mobility thin film 22b of 90 nm of thickness on the glass substrate 21 so that it may adjoin mutually.

[0046]The above-mentioned career high concentration thin film 22a is constituted by the thin film which used indium oxide as the main ingredients and in which 10% of the weight of tin oxide was added as a dopant in this indium oxide, On the other hand, the above-mentioned career high mobility thin film 22b is constituted by the indium oxide thin film in which the dopant is not added. The thin film 22a is formed without heating the glass substrate 21 by the magnetron sputtering method which uses an ITO target using the annealing method after low-temperature membrane formation, On the other hand, the thin film 22b uses an indium oxide target, and membranes are formed, without heating the glass substrate 21 in the NSUPATTA atmosphere which introduced the comparatively larger oxygen gas considering argon gas as a base, Next, on the conditions of 200 °C to 1 hour, heating annealing processing is performed to these both thin films, and it is formed in them.

[0047]And the carrier mobility, carrier concentration, specific resistance, and sheet resistivity were measured about the transparent electrode 22 which comprised these thin films 22a and 22b.

[0048]As a result, as for  $41.5\text{-cm}^2/\text{V}\cdot\text{sec}$  and carrier concentration,  $8.5 \times 10^{20}\text{ cm}^{-3}$  and specific resistance of carrier mobility were  $1.77 \times 10^{-4}\text{ }\Omega\cdot\text{cm}$ , and sheet resistivity was  $6.55\text{ }\Omega/\text{sq}$ .

[Example 3] As the electrode plate for displays concerning this example is shown in drawing 3, that principal part comprises the 0.7-mm-thick glass substrate (float blue plate provided with the undercoat layer of  $\text{SiO}_2$ ) 31, and the transparent electrode 32 provided on this glass substrate 31.

[0049]The above-mentioned transparent electrode 32 is constituted by the two-layer film of 270 nm of sum total thickness which comprises the career high mobility thin film 32b of 90 nm of thickness and the career high concentration thin film 32c of 180 nm of thickness which were laminated one by one on the glass substrate 31 so that it may adjoin mutually.

[0050]The above-mentioned career high mobility thin film 32b is constituted by the thin film in which 0.3% of the weight of zirconium oxide was added as a dopant in indium oxide, On the other hand, the above-mentioned career high concentration thin film 32c is constituted by the thin film which used indium oxide as the main ingredients and in which 10% of the weight of tin oxide was added as a dopant in this indium oxide. And after membranes are formed by each using the annealing method after low-temperature membrane formation, without heating the glass substrate 31 by a magnetron sputtering method, on the conditions of 220 °C to 1 hour, these thin films 32b and 32c perform heating annealing processing, and are formed.

[0051]And the carrier mobility, carrier concentration, specific resistance, and sheet resistivity were measured about the transparent electrode 32 which comprised these thin films 32b and 32c.

[0052]As a result, as for  $44.2\text{-cm}^2/\text{V-sec}$  and carrier concentration,  $9.9 \times 10^{20}\text{cm}^{-3}$  and specific resistance of carrier mobility were  $1.43 \times 10^{-4}\text{ ohm-cm}$ , and sheet resistivity was  $5.3\text{ohm}/\square$ .

[Example 4] As a dopant, replaced the electrode plate for displays concerning this example with zirconium oxide, and oxidation hafnium was used for it, and it made those loadings 0.7 % of the weight, and also it is the same as that of Example 3.

[0053]As for the carrier mobility of the obtained transparent electrode,  $8.8 \times 10^{20}\text{cm}^{-3}$  and the specific resistance of  $39\text{-cm}^2/\text{V-sec}$  and carrier concentration were  $1.82 \times 10^{-4}\text{ ohm-cm}$ .

[Example 5] As a dopant, replaced the electrode plate for displays concerning this example with zirconium oxide, and titanium oxide was used for it, and it made those loadings 0.2 % of the weight, and also it is the same as that of Example 3.

[0054]The carrier mobility of the obtained transparent electrode, carrier concentration, and specific resistance were the same as that of the case of the above-mentioned Example 4, and abbreviation.

[0055]

[Effect of the Invention]According to the invention concerning claims 1-8, it is constituted by the bilayer film or multilayer film of the high career high mobility thin film of carrier mobility, and a career high concentration thin film with high carrier concentration which the transparent electrode adjoined mutually and was laminated, In order that each thin film of the above-mentioned bilayer film or a multilayer film may act each other mutually, it becomes possible to decrease the specific resistance and sheet resistivity as a whole.

[0056]Therefore, it has an effect which can form the transparent electrode which moreover has

high conductivity with a thin film.

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[Translation done.]

## \* NOTICES \*

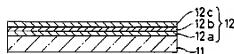
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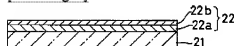
## DRAWINGS

[Drawing 1]

11: 基材  
12: 透明膜  
12a: 11の表面に形成された透明膜  
12b: 11の表面に形成された透明膜  
12c: 11の表面に形成された透明膜



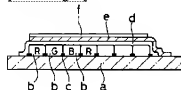
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]

\* NOTICES \*

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- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

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CLAIMS

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[Claim(s)]

[Claim 1]In an electrode plate for displays provided with a transparent electrode constituted with a transparent conducting film on a substrate, An electrode plate for displays, wherein the above-mentioned transparent conducting film is constituted with a bilayer film or a multilayer film of a high career high mobility thin film of carrier mobility, and a career high concentration thin film with high carrier concentration which adjoined mutually and was laminated.

[Claim 2]The electrode plate for displays according to claim 1, wherein carrier mobility of the above-mentioned career high mobility thin film is more than  $60\text{-cm}^2/\text{V}\cdot\text{sec}$  and carrier concentration of the above-mentioned career high concentration thin film is more than  $9 \times 10^{20}\text{cm}^{-3}$ .

[Claim 3]The electrode plate for displays according to claim 1 or 2, wherein the above-mentioned transparent conducting film is constituted with an indium oxide thin film which added a dopant.

[Claim 4]The electrode plate for displays according to claim 3, wherein the above-mentioned dopant is tin oxide.

[Claim 5]The electrode plate for displays according to claim 3, wherein the above-mentioned dopant is zirconium oxide.

[Claim 6]The electrode plate for displays according to claim 3, wherein the above-mentioned dopant is oxidation hafnium.

[Claim 7]The electrode plate for displays according to claim 3, wherein the above-mentioned dopant is titanium oxide.

[Claim 8]The above-mentioned career high mobility thin film is constituted by indium oxide thin film which added a dopant zero to 3% of the weight, The electrode plate for displays according to any one of claims 1 to 7, wherein the above-mentioned career high concentration thin film is constituted with an indium oxide thin film which added a dopant 4% of the weight or more.

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[Translation done.]